2000

STS-99 (Shuttle Radar Topography Mission)

Endeavour
Pad A
97th Shuttle mission
14th flight OV-105
50th KSC landing

Crew:
Kevin R. Kregel,
Commander (4th Shuttle flight)
Dominic Gorie, Pilot (2nd)
Janet L. Kavandi, Mission Specialist, (2nd)
Janice Voss, Mission Specialist, (5th)
Mamoru Mohri, Mission Specialist (2nd) (National Space and Development Agency of Japan)
Gerhard P.J. Thiele Mission Specialist (1st) (European Space Agency)

Orbiter Preps (move to):
OPF bay 2 – Dec. 16, 1998
VAB – Dec. 2, 1999
Pad 39A – Dec. 13, 1999

Launch:
Feb. 11, 2000, at 12:43:40 p.m. EST.

STS-99 faced a series of launch delays and one scrub before launching successfully. The mission was originally scheduled to fly on Sept. 16, 1999. But in mid-August, the launch date was postponed until October because of wiring concerns throughout the Shuttle fleet. With so much of Endeavour's wiring requiring inspection, the target date for launch was shifted to no earlier than Nov. 19. Shuttle managers later decided to preserve the option to launch either STS-99, or STS-103, the Third Hubble Servicing Mission, first. It was decided in October that STS-103 would fly first, and the launch of STS-99 was set for Jan. 13, 2000. In December that date came under review, and a new launch date of no earlier than Jan. 31 was set.

The scheduled launch on Jan. 31, 2000, was scrubbed because of unacceptable weather conditions. However, late in the count, an anomaly occurred with the No. 2 enhanced master events controller (EMEC), which also would have prevented the launch on that day. The EMEC was removed and replaced and the launch rescheduled until 12:30 p.m. EST on Feb. 11. About three hours prior to the scheduled launch, an unexpected pressure drop was detected in hydraulic system 1. The pressure drop was determined to be the result of a normal sequence of prelaunch events. Discussions of the pressure drop resulted in a 13-minute, 40-second launch delay.

Landing:
Feb. 22, 2000, 6:22:23 a.m. EDT.

Runway 33, Kennedy Space Center, Fla. Rollout distance: 9,943 feet. Rollout time: 1 minute, 2 seconds. Mission duration: 11 days, 5 hours, 38 minutes. Landed on orbit 181. Logged about 4.7 million statute miles. Landed on the second of two Florida landing opportunities. The first opportunity was at 4:50 p.m., but cross winds at the Shuttle Landing Facility violated established weather constraints. The landing marked the 21st consecutive landing at KSC, and the 50th landing at KSC overall.

Mission Highlights:

The Shuttle Radar Topography Mission mast was deployed successfully to its full length, and the antenna was turned to its operation position. After a successful checkout of the radar systems, mapping began at 12:31 a.m., less than 12 hours after launch. Crew members, split into two shifts so they could work around the clock, began mapping an area from 60 degrees north to 56 degrees south. Data was sent to Jet Propulsion Laboratory for analysis and early indications showed the data to be of excellent quality.

Mapping proceeded fairly smoothly, but during an attitude-hold period for payload mapping during the second day of flight, it was determined that orbiter propellant usage had doubled from 0.07 to 0.15 percent an hour. The increase was caused by a failure of the payload cold-gas thrust system that was used to offset the gravity gradient torque of the mast.

As a result of this failure, orbiter propellant was being used at a higher-than-planned rate to maintain the attitude of the vehicle. Measures to reduce the expenditure were evaluated and based on the analysis, enough propellant could be saved to complete the planned 9-day plus science mission.

The first of a series of "flycast" maneuvers during the mission was also made on the second day of flight. The flycast maneuver was designed to reduce strain on the almost-200-foot mast extending from Endeavour's

cargo bay when adjustments to Endeavour's orbit were needed.

The orbiter, which flies tail-first during mapping operations, is moved to a nose-first attitude with the mast extending upward. A brief reaction control system pulse begins the maneuver. The mast deflects slightly backwards, then rebounds forward. As it reaches vertical, a stronger thrust is applied, arresting the mast's motion and increasing the orbiter's speed.

Radar data gathering concluded at 6:54 a.m. EST on the tenth day of flight after a final sweep across Australia. During 222 hours and 23 minutes of mapping, Endeavour's radar images filled 332 high density tapes and covered 99.98 percent of the planned mapping area – land between 60 degrees north latitude and 56 degrees south latitude – at least once and 94.6 percent of it twice. Only about 80,000 square miles in scattered areas remained unimaged, most of them in North America and most already well mapped by other methods. Enough data was gathered to fill the equivalent of 20,000 CD's.

Also aboard Endeavour was a student experiment called EarthKAM, which took 2,715 digital photos during the mission through an overhead flight-deck window. The NASA-sponsored program lets middle school students select photo targets and receive the images via the Internet. The pictures are used in classroom projects on Earth science, geography, mathematics and space science. More than 75 middle schools around the world participated in the experiment, which set a record. On four previous flights combined, EarthKAM sent down a total of 2,018 images.

STS-101 (3rd ISS Flight)

Atlantis

Pad A

98th Shuttle mission
21st flight OV-104
22nd consecutive KSC landing

Crew:

James D. Halsell Jr., Commander (5th Shuttle flight)
Scott J. "Doc" Horowitz, Pilot (3rd)
Mary Ellen Weber, Mission Specialist (2nd)
James S. Voss, Mission Specialist (4th)
Jeffrey N. Williams, Mission Specialist (1st)
Susan J. Helms, Mission Specialist (4th)
Yury Usachev, Mission Specialist and cosmonaut, (1st on Shuttle, twice on Mir)

Orbiter Preps:

OPF 3 – Sept. 27, 1998; Feb. 17, 1999; Sept. 24, 1999
VAB – Dec. 10, 1998 (storage); Feb. 8, 1999 (transfer aisle); July 26, 1999 (storage); Aug. 25, 1999 (transfer aisle); Sept. 1, 1999 (high bay 2); March 17, 2000
Pad A– March 25, 2000

Launch:

May 19, 2000 at 6:11:10 a.m. EDT.

After three launch delays in April caused by high winds at the launch site and overseas emergency landing strips, Atlantis blasted off from KSC's Launch Pad 39A on time. A crew of six American astronauts and one Russian cosmonaut were on their way to pay a "home improvement" house call on the fledgling International Space Station (ISS).

Landing:

May 29, 2000, at 2:20:19 a.m. EDT.

Runway 15, Kennedy Space Center, Fla. Rollout distance: 8892 feet. Rollout time: 62 seconds. Wheel stop occurred at 2:21:17 a.m. EDT. Mission duration: 9 days, 20 hours, 9 minutes and 9 seconds. Landed on orbit 155. Logged 4,076,000 miles. Landed on first opportunity at KSC, marking the 22nd consecutive landing in Florida and 29th in the last 30 missions. Also the 14th nighttime landing in Shuttle history.

Mission Highlights:

On their 10-day mission, the astronauts completed one spacewalk (EVA), equipped the ISS with new or replacement gear and transferred more than a ton of supplies into the Space Station for use by future residents of the ISS.

The EVA marked the fifth spacewalk for construction of the ISS, the 49th conducted from a Space Shuttle, and the 85th overall conducted by U.S. astronauts. During the six-hour, 44-minute EVA, Mission Specialists James Voss and Jeffrey Williams secured a United States-built crane installed on the Station last year; installed the final parts of a Russian-built crane, Strela, on the Pressurized Mating Adapter-1 that connects the Unity node to the Zarya control module; replaced a faulty antenna for one of the station's communications systems; and installed

several handrails and a camera cable on the ISS exterior.

Mission Specialist Mary Ellen Weber operated the Shuttle's robotic arm, which she used to maneuver Voss during much of the spacewalk.

Work inside the Space Station followed. Before entering the Space Station, the crew opened various hatches into and within the different modules, in this order: PMA-2, Unity node, PMA-1, Zarya, and instrumentation cargo compartment on Zarya. Over the course of three days, the crew installed four batteries and associated electronics; 10 new smoke detectors in the Zarya module; four new cooling fans; additional cables for the Zarya computer to enhance capabilities; a new communications memory unit; and a new power distribution box for the U.S.-built communications system.

Next came the transfer of supplies – more than 3,300 pounds of gear ranging from clothes, tools, can openers, sewing kits and trash bags to a treadmill, an exercise bicycle ergometer and IMAX film camera. The crew also filled four 12-gallon water containers for use by future resident astronauts aboard the ISS.

During the mission, Commander Halsell and Pilot Horowitz also fired Atlantis' jets three times to boost the ISS about 27 miles into a slightly higher orbit of 225 miles.

When stowage was complete, the crew reversed the procedure to close the hatches in the Space Station, with the final hatch shut at 4:40 a.m. EDT., May 26.

Undocking with the Space Station occurred at 7:02 p.m. EDT, May 26. Pilot Horowitz backed Atlantis away and then flew a half-circle around the station before firing Atlantis' jets in a final separation burn at 7:41 p.m. EDT.

STS-106 (4th ISS Flight)

Atlantis
Pad B

99th Shuttle mission
22nd Flight of OV-104
52nd KSC landing

Crew:

Terrence W. Wilcutt, Commander (4th Shuttle flight)
Scott D. Altman, Pilot (2nd)
Edward Lu, Mission Specialist (2nd)
Yuri I. Malenchenko, Mission Specialist (1st)
Boris V. Morokov, Mission Specialist (1st)
Richard A. Mastracchio, Mission Specialist (1st)
Daniel C. Burbank, Mission Specialist (1st)

Orbiter Preps (move to):

OPF Bay 3 – May 29, 2000
VAB – Aug. 7, 2000
Pad 39B – Aug. 13, 2000

Launch:

Sept. 8, 2000, 8:45:47 a.m. EDT.

STS-106 launched as planned at 8:45 a.m. with no unscheduled holds during the flawless countdown.

Landing:

Sept. 20, 2000, 3:58:01 a.m. EDT.

Runway 15, Kennedy Space Center, Fla. Rollout distance: 9,127 feet. Rollout time: 1 minute 13 seconds. Mission duration: 11 days, 19 hours, 12 minutes, 15 seconds. Landed on orbit 185. Logged 4.9 million statute miles. Landed on first opportunity at KSC, marking 23rd consecutive landing in Florida and the 30th landing of a Shuttle at KSC in the last 31 flights.

Mission Highlights:

STS-106, during its 11-day mission to the International Space Station (ISS), completed all assigned mission objectives to prepare the Station for the first crew scheduled to launch in October. The mission to the 143-foot-long Station focused on unloading nearly three tons of cargo from the orbiter and a Progress supply craft already docked to the opposite end of the ISS.

On flight day two, Atlantis completed a successful rendezvous and docking with the ISS in early morning setting the stage for six days of outfitting

A 6-hour and 14-minute Extravehicular Activity (EVA) was completed successfully on day three, 16 minutes ahead of the planned schedule, by Lu and Malenchenko. The spacewalk's objective focused on routing and connecting nine power, data and communications cables between the Zvezda module and the other Russian-built module, Zarya, as well as installing the six-foot-long magnetometer to the Station to serve as a compass showing the Station in respect to the Earth.

Lu and Malenchenko used tethers and handrails along the ISS to make their way to a point more than 100 feet above the cargo bay, the farthest any tethered spacewalker has ventured outside the Shuttle. They completed this with the assistance of their inside crewmates Burbank and Mastracchio who deftly maneuvered them around with the robotic arm. This spacewalk celebrates the sixth spacewalk in support of the Station assembly and the 50th spacewalk in Space Shuttle history.

On flight day four the crew entered the International Space Station through Pressurized Mating Adapter-2 (PMA-2) to begin the transfer operations of more than three tons of hardware and supplies. Atlantis' crew was the first to see the interior of the Russian Zvezda service module since it was launched from the Baikonur Cosmodrome in July. Additionally, a reboost was performed using the orbiter's Reaction Control System (RCS) to place the Station in a higher orbit.

Transfer of supplies and maintenance tasks continued well into the fifth day, while orbiter consumables remain above the required levels allowing managers to extend the mission one additional day.

Activities on flight day five included the installation of three batteries inside Zvezda. In order to reduce the weight for launch, Zvezda was launched with only five of its eight batteries in place.

Lu and Malenchenko spent much of flight day seven installing voltage and current stabilizers in Zvezda. Components of the Elektron system, equipment sent into orbit to separate water into oxygen and hydrogen, were installed and will be activated after the first crew arrives.

The crew transferred more than 6,000 pounds of material – including six, 100 pound bags of water, all of the food for the first resident crew, office supplies, onboard environmental supplies, a vacuum cleaner and a computer and monitor – to the interior of the Station.

The astronauts spent a total of 5 days, 9 hours and 21 minutes inside the Station before closing the hatch on the orbiting outpost. Wilcutt and Altman commanded a series of four altitude boosts to place the Station in an orbit of approximately 241 by 233 statute miles, raising the average altitude by 14 miles. After spending 7 days, 21 hours and 54 minutes linked to the Station, Atlantis undocked at 6:45 p.m. EDT as Wilcutt and Altman fired Atlantis' jets to move to a distance of about 450 feet for a double-loop flyaround.

STS-92 (5th ISS Flight)

Discovery
Pad A

100th Shuttle mission
28th Flight of OV-103
1st Edwards Air Force Base landing since 1996

Crew:

Brian Duffy, Commander (4th Shuttle flight)
Pamela A. Melroy, Pilot (1st)
Leroy Chiao, Mission Specialist (3rd)
William "Bill" S. McArthur, Mission Specialist (3rd)
Peter "Jeff" J.K. Wisoff, Mission Specialist (4th)
Michael E. Lopez-Alegria, Mission Specialist (2nd)
Koichi Wakata, Mission Specialist (2nd)

Orbiter Preps (move to):

OPF Bay 1 – Dec. 27, 1999
VAB – Aug. 24, 2000
Pad 39B – Sept. 11, 2000

Launch:

Oct. 11, 2000, 7:17:00 p.m. EDT.

STS-92 was scheduled to launch on Oct. 5, 2000. However, prior to loading cryogenics into the external tank, the mission was delayed when it was noted through film review on the previous mission (STS-106) that the right-hand external tank to orbiter attach bolt failed to retract properly. Following the scrub decision an orbiter liquid oxygen pogo accumulator re-circulation valve located in Discovery's Main Propulsion System failed to respond properly and a decision was made to remove and replace the valve. The launch was rescheduled for Oct. 9.

The second launch attempt was postponed prior to tanking due to higher than acceptable winds at the pad preventing fueling of the external tank. The launch was delayed 24 hours and rescheduled for Oct.10. During the planned three-hour hold on the next launch attempt, a ground support equipment pin with a tether, used on access platforms, was observed on the external tank-to-orbiter liquid oxygen feed line during

final pad inspections. The launch was postponed at the T-20 minute mark due to potential damage the pin and tether might cause to the orbiter during launch.

Launch was rescheduled 24 hours later and occurred without further delay on Oct.11 at 7:17 p.m. EDT.

Landing:

Oct. 24, 2000, 5 p.m. EDT.

Runway 22, Edwards Air Force Base, Calif. Rollout distance: 9,090 feet. Rollout time: 1 minute, 15 seconds. Mission duration: 12 days, 21 hours, 40 minutes, 25 seconds. Landed on orbit 202. Logged 5.3 million statute miles. Landing was originally scheduled at KSC on Oct. 22, 2000. However, landing opportunities at KSC were waived due to higher than allowable crosswinds at the SLF. The next landing attempt was scheduled for Oct. 23, but winds remained in excess of limits at KSC. Landing opportunities at Edwards were also waived due to rain showers within 30 miles of the planned runway. Winds were again in excess of limits at KSC on the third day, and, as a result, all KSC opportunities were waived. The Space Shuttle Discovery landed on the first opportunity at Edwards Air Force Base.

Mission Highlights:

STS-92, during its 12-day mission to the International Space Station (ISS), completed all assigned objectives to install the Zenith Z1 Truss and the third pressurized mating adapter (PMA 3) for use as a docking port for subsequent Shuttle missions.

In the afternoon of flight day two, Discovery and her crew completed a successful rendezvous and docking with the International Space Station setting the stage for six days of construction and outfitting.

On flight day three, Japanese Astronaut, Koichi Wakata, deftly maneuvered Discovery's robotic arm to lift the Zenith Z1 Truss from the Shuttle's payload bay and berthed it to a port on the Unity connecting module. Inside Unity, Pilot Pam Melroy and crewmate Jeff Wisoff opened the hatch where the new truss was attached and installed grounding connections between the framework and the Station.

Discovery's five mission specialists, Leroy Chiao, Bill McArthur, Jeff Wisoff, Mike Lopez-Alegria and Koichi Wakata, performed a total of four extravehicular activities (EVA) during the STS-92 mission. They included the following assignments:

EVA #1 – 6-hours, 28-minutes – connection of electrical umbilicals to provide power to heaters and conduits located on the Z1 Truss; relocation and deployment of two communication antenna assemblies; and installation of a toolbox for use during on-orbit construction.

EVA #2 – 7-hours, 7-minutes – attachment of the PMA 3 to the ISS and preparation of the Z1 Truss for future installation of the solar arrays that will be delivered aboard STS-97 in late November.

EVA #3 – 6-hours, 48-minutes – installation of two DC-to-DC converter units atop the Z1 Truss for conversion of electricity generated by the solar arrays to the proper voltage.

EVA #4 – 6-hours, 56 minutes – testing of the manual berthing mechanism; deployment of a tray that will be used to provide power to the U.S. Lab; and removal of a grapple fixture from the Z1 Truss. Two small rescue backpacks that could enable a drifting astronaut to regain the safety of the spacecraft were also tested.

On flight day nine, the crew of Discovery shifted their attention to the interior of the ISS as they completed connections for the newly installed Z1 Truss external framework and began transferring equipment and supplies for the first resident crew of the ISS who arrived in November. They also successfully completed testing of the four control moment gyroscopes that will be used to orient the ISS as it orbits Earth.

STS-97
6th ISS flight (4A)

Endeavour

Pad B

101st Shuttle mission
15th Flight of OV-105

Crew:

Brent Jett, Commander (3rd Shuttle flight)
Michael Bloomfield, Pilot (2nd)
Joseph Tanner, Mission Specialist (3rd)
Carlos Noriega, Mission Specialist (2nd)
Marc Garneau, Mission Specialist (3rd) (Canadian Space Agency)

Orbiter Preps (move to):

OPF Bay 2 - Feb. 23, 2000
VAB - Oct. 25, 2000
Pad 39B - Oct. 31, 2000

Launch:

Nov. 30, 2000 at 10:06:01 p.m. EST.

Endeavour blasted off on time from Launch Pad 39B at the Kennedy Space Center on the 101st mission in Space Shuttle history. The crew of five astronauts were on the sixth construction flight for the International Space Station (ISS). There were no unscheduled holds or delays during the flawless countdown.

Landing:

Dec. 11, 2000 at 6:04:20 p.m. EST.

Landed on first opportunity at KSC, Runway 15, Kennedy Space Center, Fla. Main Gear Touchdown: 6:03:25 p.m. EST. Nose Gear Touchdown: 6:03:34 p.m. EST. Wheel Stop: 6:04:20. Rollout time: 57 seconds. Mission Elapsed Time: 10 days, 19 hours, 58 seconds. Distance on orbit: 4,476,164 million miles. Endeavour landed on orbit 171, marking the 16th night landing and the 53rd KSC landing in Space Shuttle history.

Mission Highlights:

On their 11-day mission, the astronauts completed three spacewalks, or EVAs, to deliver and connect the first set of U.S.-provided solar arrays to the International Space Station, prepare a docking port for arrival of the U.S. Laboratory Destiny, install Floating Potential Probes to measure electrical potential surrounding the Station, install a camera cable outside the Unity module, and transfer supplies, equipment and refuse between Endeavour and the Station.

On Flight Day 3, Commander Brent Jett linked Endeavour to the ISS while 230 statute miles above northeast Kazakhstan.

The successful checkout of the extravehicular mobility units (EMUs), the Simplified Aid for EVA Rescue (SAFER) units, the Remote Manipulator System (RMS), the Orbiter Space Vision System (OSVS) and the Orbiter Docking System (ODS) were all completed nominally. Also, the ODS centerline camera was installed with no misalignment noted.

From inside Endeavour, Mission Specialist Garneau used the RMS to remove the P6 truss from the payload bay, maneuvering it into an overnight park position to warm its components. Mission Specialists Joseph Tanner and Carlos Noriega moved through Endeavour's docking tunnel and opened the hatch to the ISS docking port to leave supplies and computer hardware on the doorstep of the Station. On flight day 4, the Expedition One crew – Commander Bill Shepherd, Pilot Yuri Gidzenko and Flight Engineer Sergei Krikalev – entered the Unity module for the first time and retrieved the items left for them.

EVA No. 1 – Tanner and Noriega mated the P6 to the Station's Z1 truss. The starboard or first half of the P6 solar array was unfurled only after several repeat commands were given because not all of the pins would release at first. The release of the port array was delayed to allow controllers to understand the problem encountered. Also deployed was one of three photovoltaic radiators that will dissipate heat generated by on-board electronics. The spacewalk lasted 7 hours, 33 minutes.

Later, the second solar wing was deployed slowly, with stops and starts. Two rows of solar panels stuck together but were loosened by retracting then extending the arrays again. The deployment brings the span of the solar arrays to 240 feet wide and 38 feet across.

EVA No. 2 – Tanner and Noriega worked to reconfigure electrical connections so that power from the P6 solar arrays can flow to the U.S. elements of the Station. They also prepared a docking port, Pressurized Mating Adapter 2, for its move from the forward end of the Unity module in January to another area on the Space Station. That will enable the U.S. Laboratory Destiny to be attached to Unity. The docking port then will be placed on the forward end of Destiny. Noriega and Tanner also moved the S-band antenna assembly to the top of the solar array tower and release restraints holding a radiator to the tower's side. Designed to help cool Destiny, the radiator was deployed after the spacewalk. The spacewalk lasted 6 hours, 37 minutes.

EVA No. 3 – A major task on this spacewalk was increasing tension on the solar array. By retracting the starboard wing, Noriega pulled the slack cables through each take-up reel. Tanner turned the spring-loaded tension reels then let them unwind while Noriega guided the cable onto the reel grooves, increasing the tension. In other activities, Tanner and Noriega installed a centerline camera cable outside the Unity module to transmit television images that will aid the next Shuttle crew to attach Destiny. They also installed the Floating Potential Probe, which measures the electrical potential of plasma around the Station.

Following Earth-based construction tradition when a building reaches its final height, the astronauts attached an evergreen tree – the image was on a transfer bag – to the FPP in a symbol of "topping out" the Space Station. Get-ahead tasks included installing

a sensor on a radiator and small antennas, and doing a photo survey.

This third spacewalk took 5 hours and 10 minutes, bringing the total spacewalk time for the mission to 19 hours and 20 minutes. The total of spacewalk time outside the Space Station is now 88 hours and 54 minutes.

At 9:36 a.m. EST on Friday, Dec. 8, the crew paid the first visit to the Expedition One crew residing in the Space Station. Until then the Shuttle and the Station had kept one hatch closed to maintain respective atmospheric pressures, allowing the Shuttle crew to conduct their spacewalks and mission goals. After a welcome ceremony and briefing, the eight spacefarers conducted structural tests of the Station and its solar arrays, transferred equipment, supplies and refuse back and forth between the spacecraft, and checked out the television camera cable installed by Tanner and Noriega for the upcoming mission.

On Dec. 9, the two crews completed final transfers of supplies to the Station and other items being returned to Earth. The Endeavour crew said farewell to the Expedition One crew at 10:51 a.m. EST and closed the hatches between the spacecraft.

After being docked together for 6 days, 23 hours and 13 minutes, Endeavour undocked from the Station at 2:13 p.m. EST. Piloted by Michael Bloomfield, it then made an hour-long, tail-first circle of the Station. The undocking took place 235 statute miles above the border of Kazakhstan and China. The final separation burn took place near the northeast coast of South America.

The final day was spent checking out the systems for landing and talking with reporters.
